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19-4127; Rev 0; 5/08

USB 2.0 Hi-Speed Differential 8:1 Multiplexer

General Description

The MAX4999 differential Hi-Speed USB analog multiplexer features low on-capacitance (C_{ON}) switching, making it an ideal solution for the USB server/mass storage market. The MAX4999 is designed for USB 2.0 low-/full-/Hi-Speed applications with capability of supporting data rates up to 480Mbps.

The MAX4999 is a differential 8:1 multiplexer. The MAX4999 features three digital inputs to control the signal path. Typical applications include switching a USB connector between eight USB hosts and a USB device.

An enable input (EN) is provided to disable all channels and place the device into a high-impedance state (standby mode), shutting off the charge pump for minimum power consumption.

The MAX4999 operates from a +3.0V to +3.6V power-supply voltage and is specified over the -40°C to +85°C extended temperature range. The MAX4999 is available in a 5mm x 5mm, 32-pin TQFN package.

Applications

Keyboard, Video, Mouse (KVM)

Servers/RAID

Mass Storage

Workstations

Features

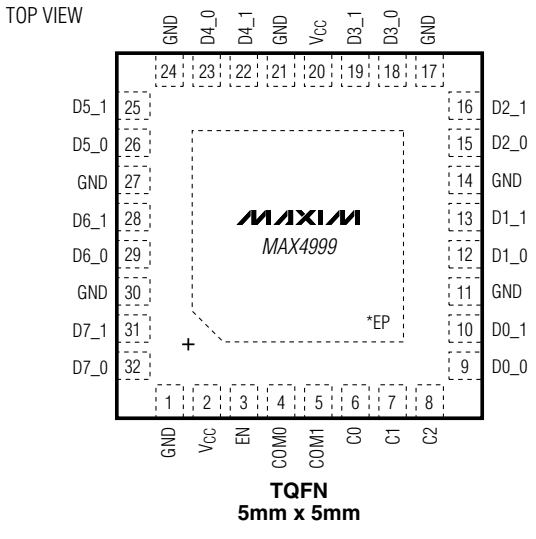
- **Single +3.0V to +3.6V Power-Supply Voltage**
- **Low 6.5Ω (typ) On-Resistance (R_{ON})**
- **-3dB Bandwidth: 1200MHz (typ)**
- **Enable Input Puts All Channels in High-Impedance State (Standby Mode)**
- **Low Operating Current (1µA) and Ultra-Low Quiescent Current (30nA) in Standby Mode**
- **Low Threshold Eliminates the Need for Translators in 1.8V Low-Voltage Systems**
- **Small 32-Pin, 5mm x 5mm, TQFN Package**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4999ETJ+	-40°C to +85°C	32 TQFN-EP*

+Denotes a lead-free package.
**EP = Exposed pad.*

Pin Configuration



TQFN
5mm x 5mm

*CONNECT EXPOSED PAD TO GND.

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

USB 2.0 Hi-Speed Differential 8:1 Multiplexer

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)
V_{CC} .....-0.3V to +4V
All Other Pins (Note 1).....-0.3V to +4V
Continuous Current (COM_ to any switch) .....±60mA
Peak Current (COM_ to any switch) (pulsed at 1ms, 10% duty cycle).....±120mA
Continuous Power Dissipation (T_A = +70°C)
32-Lead TQFN (derate 34.5mW/°C above +70°C) 2759mW
Junction-to-Case Thermal Resistance (θ_{JC}) (Note 2)
32-Lead TQFN .....2.0°C/W
Junction-to-Ambient Thermal Resistance (θ_{JA}) (Note 2)
32-Lead TQFN .....29°C/W
Operating Temperature Range .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C

Note 1: Signals exceeding GND are clamped by internal diodes. Limit forward-diode current to maximum current rating.

Note 2: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to **www.maxim-ic.com/thermal-tutorial**.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +3.0V to +3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Supply Voltage	V_{CC}		3.0		3.6	V
Quiescent Supply Current	I_O	Charge pump on			5	µA
		Charge pump off			1	
ANALOG SWITCH						
On-Resistance	R_{ON}	$I_{COM_}$ = ±10mA		6.5	12	Ω
On-Resistance Match	ΔR_{ONSC}	$V_{COM_}$ = 1V, T_A = +25°C			0.8	Ω
On-Resistance Match Between Channels	ΔR_{ONBC}	$V_{COM_}$ = 1V, T_A = +25°C			1	Ω
Leakage Current COM_, D_0, D_1	I_L	V_{CC} = +3.6V	-1		+1	µA
SWITCH AC PERFORMANCE (Note 4)						
Crosstalk	V_{DCT1}	Any switch to non-paired switch at 500MHz (Figure 3)		-30		dB
Off-Isolation	V_{OFF}	Any switch to non-paired switch at 240MHz (Figure 3)		-27		dB
Bandwidth -3dB	BW	R_L = 45Ω unbalanced (Figure 3)		1200		MHz
On-Capacitance	C_{ON}	f = 1MHz		6		pF
		Taken from S11 parameters at f = 240MHz		3.0		
Off-Capacitance	C_{OFF}	f = 1MHz, COM_		5		pF
		Taken from S11 parameters at f = 240MHz		3.0		
Propagation Delay	t_{PD}	R_L = R_S = 50Ω (Figure 2)		300		ps
Turn-On Time	t_{ON}	V_{D0} or V_{D1} = +1.5V, R_L = 300Ω, C_L = 35pF, V_{IH} = V_{CC}, V_{IL} = 0V (Figure 1)		10		µs

ELECTRICAL CHARACTERISTICS

(V_{CC} = +3.0V to +3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Turn-Off Time	t_{OFF}	V_{D0} or V_{D1} = +1.5V, R_L = 300Ω, C_L = 35pF, V_{IH} = V_{CC}, V_{IL} = 0V (Figure 1)		10		µs
Output Skew Same Port	t_{PD}	Skew between any D_0, D_1 line, same port 45Ω unbalanced I/O, f = 240MHz (Figure 2)		30		ps
SWITCH LOGIC						
Input Logic Low	V_{IL}	V_{CC} = +3.0V			0.6	V
Input Logic High	V_{IH}	V_{CC} = +3.6V	1.7			V
Input Logic Hysteresis	V_{HYST}			200		mV
Input Leakage Current	I_{LEAK}	V_{CC} = +3.6V, $V_{COM_}$ = 0V or V_{CC}	-1		+1	µA
ESD PROTECTION						
All Pins		Human Body Model		±2		kV

Note 3: All units are 100% production tested at T_A = +85°C. Limits over the operating temperature range are guaranteed by design and not production tested.

Note 4: Guaranteed by design.

Test Circuits/Timing Diagrams

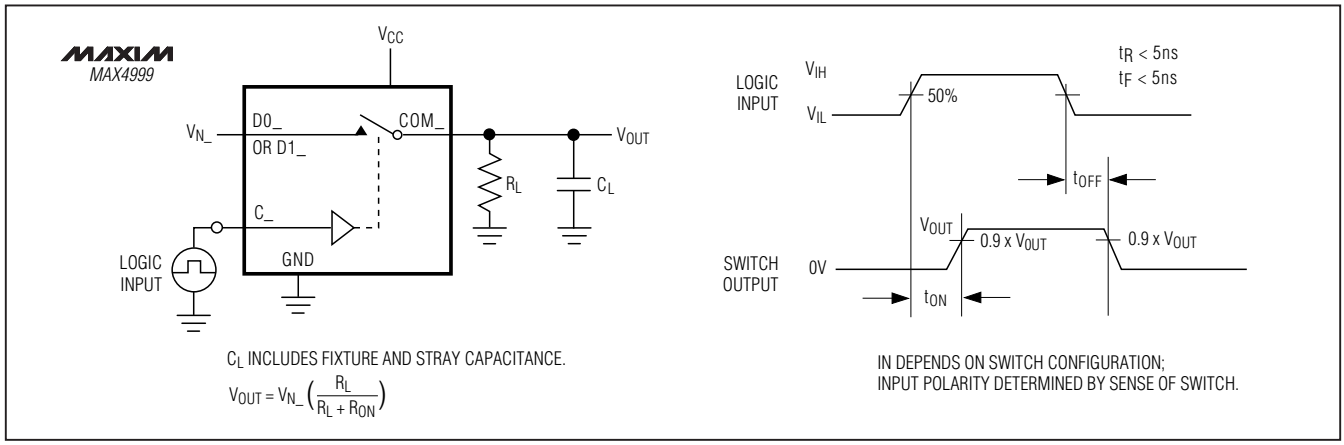


Figure 1. Switching Time

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Test Circuits/Timing Diagrams (continued)

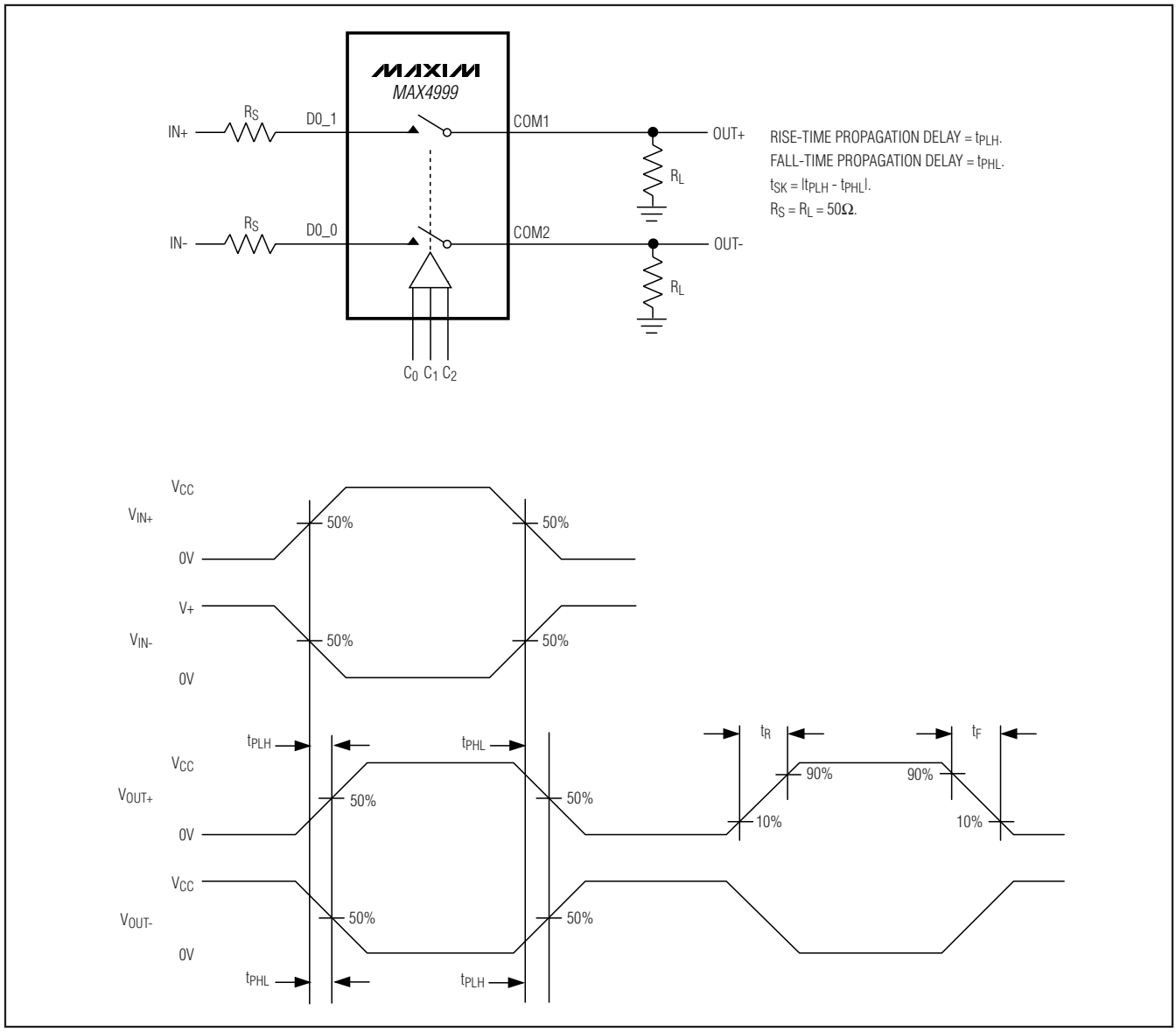
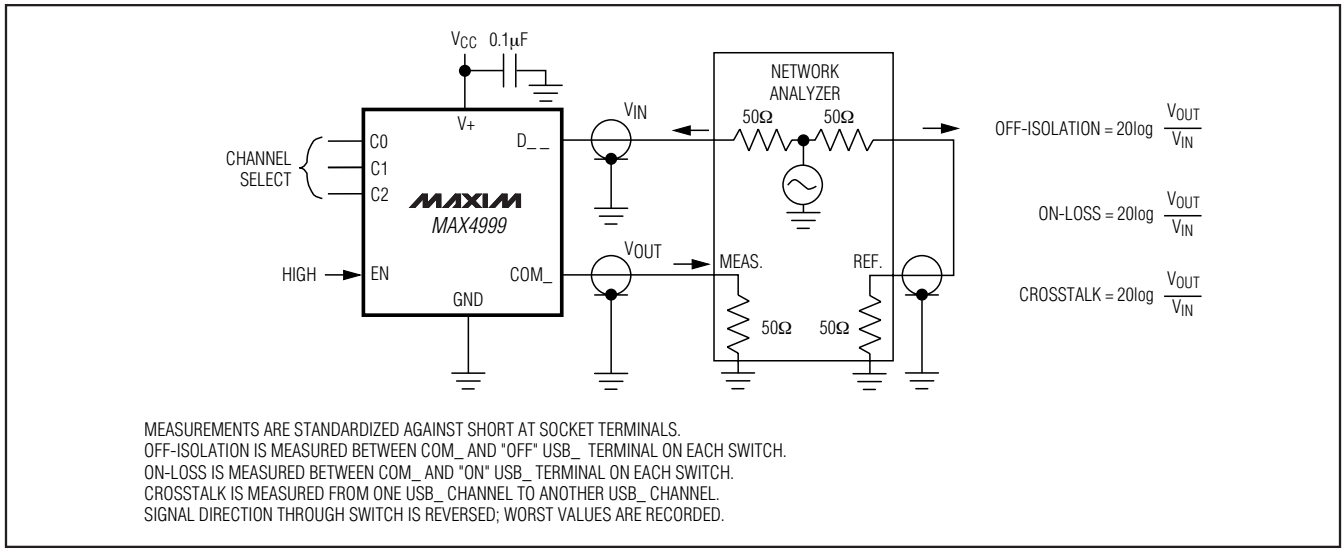


Figure 2. Propagation Delay and Skew

Test Circuits/Timing Diagrams (continued)



MEASUREMENTS ARE STANDARDIZED AGAINST SHORT AT SOCKET TERMINALS.
OFF-ISOLATION IS MEASURED BETWEEN COM_ AND "OFF" USB_ TERMINAL ON EACH SWITCH.
ON-LOSS IS MEASURED BETWEEN COM_ AND "ON" USB_ TERMINAL ON EACH SWITCH.
CROSSTALK IS MEASURED FROM ONE USB_ CHANNEL TO ANOTHER USB_ CHANNEL.
SIGNAL DIRECTION THROUGH SWITCH IS REVERSED; WORST VALUES ARE RECORDED.

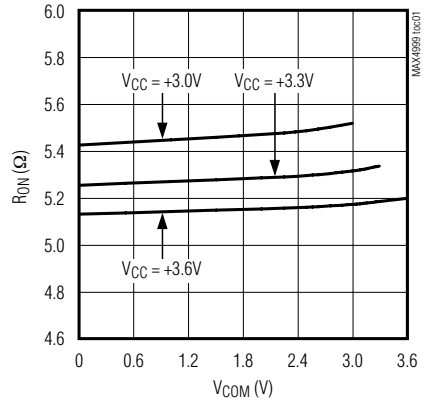
Figure 3. Off-Isolation, On-Loss, and Crosstalk

USB 2.0 Hi-Speed Differential 8:1 Multiplexer

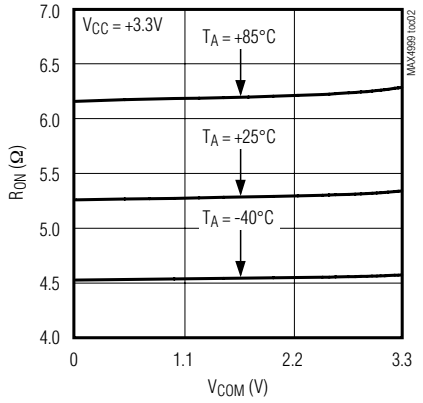
Typical Operating Characteristics

(V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)

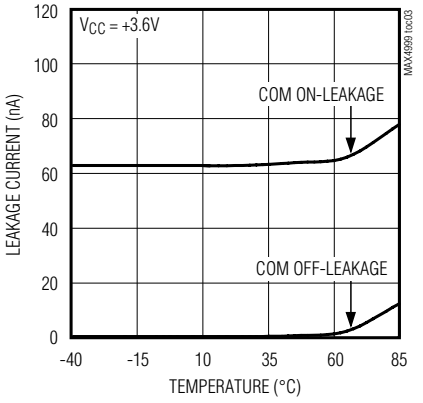
ON-RESISTANCE vs. V_{COM}



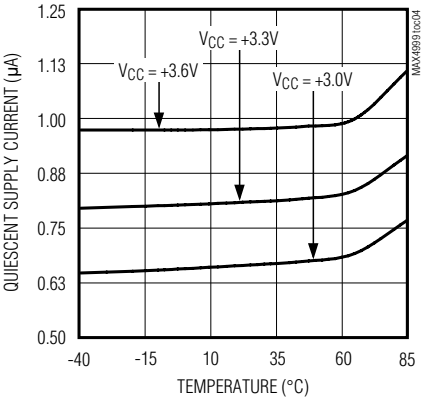
ON-RESISTANCE vs. V_{COM}



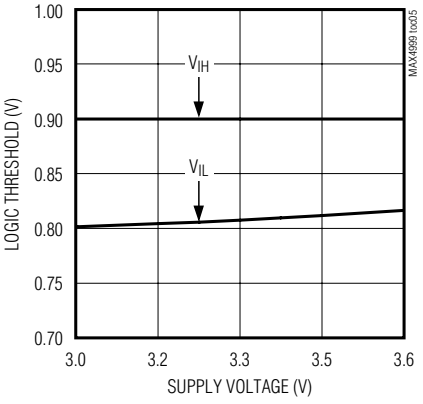
LEAKAGE CURRENT vs. TEMPERATURE



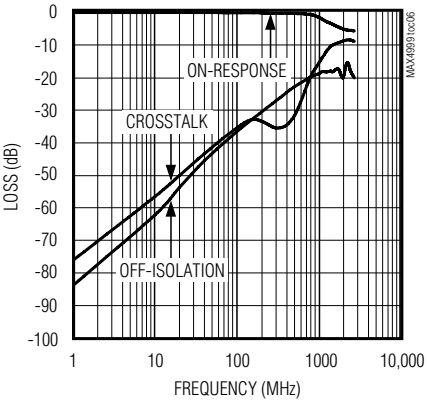
QUIESCENT SUPPLY CURRENT vs. TEMPERATURE



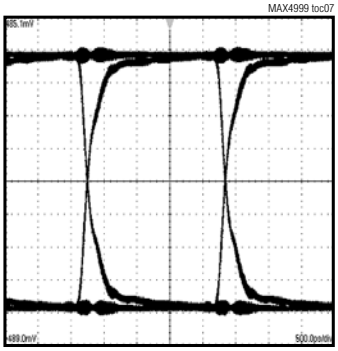
LOGIC THRESHOLD vs. SUPPLY VOLTAGE



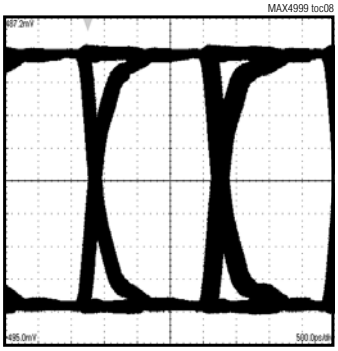
FREQUENCY RESPONSE



EYE DIAGRAM - SINGLE



EYE DIAGRAM - DOUBLE



USB 2.0 Hi-Speed Differential 8:1 Multiplexer

Pin Description

PIN	NAME	FUNCTION
1, 11, 14, 17, 21, 24, 27, 30	GND	Ground
2, 20	V_{CC}	Power-Supply Input. Bypass V_{CC} to GND with a 0.1µF capacitor placed as close to V_{CC} as possible.
3	EN	Enable Input
4	COM0	Analog Switch Common D- Terminal
5	COM1	Analog Switch Common D+ Terminal
6	C0	Control Input 0
7	C1	Control Input 1
8	C2	Control Input 2
9	D0_0	Analog Switch 0 D- Terminal
10	D0_1	Analog Switch 0 D+ Terminal
12	D1_0	Analog Switch 1 D- Terminal
13	D1_1	Analog Switch 1 D+ Terminal
15	D2_0	Analog Switch 2 D- Terminal
16	D2_1	Analog Switch 2 D+ Terminal
18	D3_0	Analog Switch 3 D- Terminal
19	D3_1	Analog Switch 3 D+ Terminal
22	D4_1	Analog Switch 4 D+ Terminal
23	D4_0	Analog Switch 4 D- Terminal
25	D5_1	Analog Switch 5 D+ Terminal
26	D5_0	Analog Switch 5 D- Terminal
28	D6_1	Analog Switch 6 D+ Terminal
29	D6_0	Analog Switch 6 D- Terminal
31	D7_1	Analog Switch 7 D+ Terminal
32	D7_0	Analog Switch 7 D- Terminal
—	EP	Exposed Pad. Connect EP to GND or leave unconnected.

Detailed Description

The MAX4999 differential Hi-Speed USB analog multiplexer features low on-capacitance (C_{ON}) and low on-resistance (R_{ON}) necessary for high-performance switching applications. The low C_{ON} is designed for USB server/mass storage devices. This device is ideal for USB 2.0 Hi-Speed applications at 480Mbps, while also meeting the requirements for USB low-/full-speed applications.

Digital Control Inputs (C0, C1, C2)

The MAX4999 provides three digital control inputs (C0, C1, C2) to select the analog signal path between the COM_ and D-/D+ channels. The truth table for the MAX4999 is shown in the *Functional Diagram/Truth Table.* Driving the control inputs rail-to-rail minimizes power consumption.

Enable Input (EN)

The MAX4999 features an enable input that when driven low, places the device in standby mode. In standby mode, all channels are high impedance and the internal charge pump is disabled, thus minimizing the quiescent supply current. For normal operation, drive EN high.

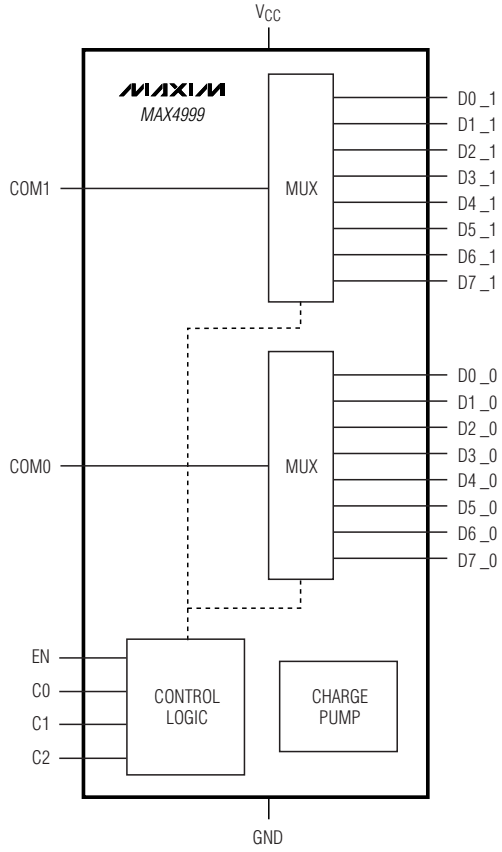
Analog Signal Levels

Signals applied to COM1 are routed to D_ _1 terminals. Signals applied to COM0 are routed to D_ _0 terminals. This multiplexer is bidirectional, allowing COM_ and D-/D+ terminals to be configured as either inputs or outputs. Additionally, the MAX4999 can be used for non-USB signals if the signals fall within the normal operating range.

The MAX4999 features an internal charge pump that allows signal levels greater than the supply voltage. Limit the analog input/output signal level to no more than the *Absolute Maximum Ratings*.

USB 2.0 Hi-Speed Differential 8:1 Multiplexer

Functional Diagram/Truth Table



MAX4999				
EN	C2	C1	C0	FUNCTION
1	0	0	0	COM_→D0
1	0	0	1	COM_→D1
1	0	1	0	COM_→D2
1	0	1	1	COM_→D3
1	1	0	0	COM_→D4
1	1	0	1	COM_→D5
1	1	1	0	COM_→D6
1	1	1	1	COM_→D7
0	X	X	X	STANDBY MODE. ALL SWITCHES IN HIGH-IMPEDANCE STATE. CHARGE PUMP IS OFF.

X = DON'T CARE

Applications Information

Increasing USB Channels

The MAX4999 features an enable input that allows two MAX4999s to be connected, allowing multiplexing between 16 USB channels. Figure 4 shows the typical application with a single USB common terminal multiplexed to eight channels (8:1). See the Eye Diagram - Single graph in the *Typical Operating Characteristics*. Figure 5 shows two MAX4999 devices configured with the USB common terminal multiplexed to 16 USB channels (16:1). See the Eye Diagram - Double graph in the *Typical Operating Characteristics*. The MAX4999 was designed to be symmetrical so that the two common ports may be wired in parallel with very short wiring to create a 16:1 configuration. When operating in 16:1 configuration, interchange COM0 and COM1 on the second device to reverse the D+ and D- pins. This minimizes vias and crossovers (Figure 5).

USB Switching

The MAX4999 analog multiplexers are fully compliant with the USB 2.0 specification. The low on-resistance and low on-capacitance of the MAX4999 make it ideal for high-performance switching applications.

Board Layout

Hi-Speed switches require proper layout and design procedures for optimum performance. Keep design-controlled impedance PCB traces as short as possible. Ensure that high-quality bypass ceramic capacitors (X7R, X5R or better) are placed as close to the device as possible and use large ground planes where possible.

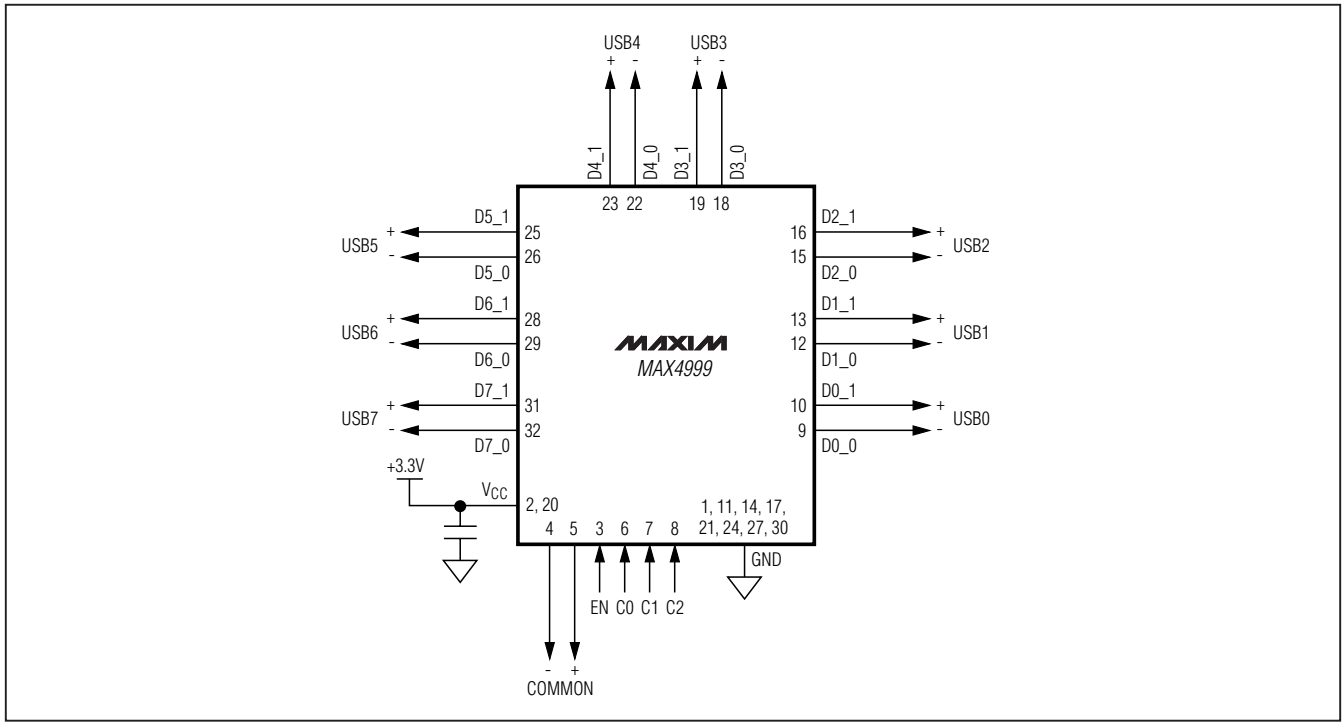


Figure 4. The MAX4999 Multiplexes Between Eight Differential Channels (8:1)

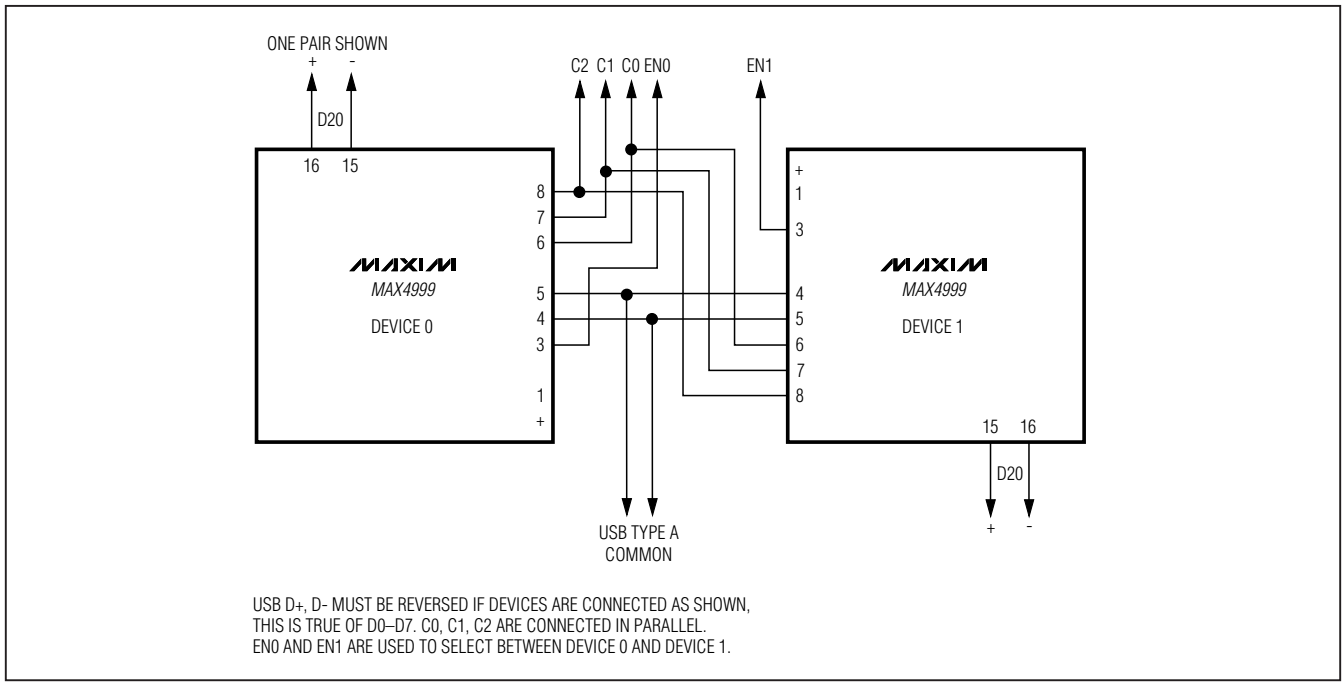


Figure 5. Combining Two MAX4999 Devices for 16:1 USB Connections

USB 2.0 Hi-Speed Differential 8:1 Multiplexer

Chip Information

PROCESS: CMOS

Package Information

For the latest package outline information, go to **www.maxim-ic.com/packages**.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
32 TQFN-EP	T3255-4	**21-0140**

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